PHYSICS 20-30

PROGRAM OUTLINE

DRAFT: 88 10 31

CURRICULUM

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A35
1978
gr.10-12
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1988

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Goals and Objectives

1.00 Acquire a Foundation in the Natural Sciences.

1.10 know some of the fundamental ideas of Physics:

1.11 the conservation of physical quantities of mass, energy, momentum and charge

1.12 the physical interactions associated with basic forces such as gravitational, electromagnetic, weak nuclear, and strong nuclear, that result in a transfer of mass-energy, momentum and/or charge.

1.13 the wave and particle concepts that are useful in describing and predicting continuous and discrete physical states and interactions.

1.20 view the knowledge as part of a systematic explanation for natural phenomena;

1.30 use the knowledge learned when interpreting natural phenomena.

2.00 Comprehend the Nature of Science.

2.10 understand that science is a disciplined way to develop explanations for the events and objects of the natural word:

2.11 observable data plays a central role in the development of scientific knowledge

2.12 scientific explanations are developed through interpretations and conceptual inventions which are theoretical in nature

2.13 proposed theories may subsequently be supported or refuted by experimental results.

2.20 develop skill in the processes of science: questioning; acquiring data; proposing ideas; designing experiments; gathering, processing and interpreting data into a unified theory.

2.30 recognize that scientific knowledge is cumulative and subject to change.

3.00 Understand the Relationship between Technology and Science.

3.10 view technology as a means of solving practical problems;

3.20 know that the scope of technological development includes both techniques and products;

3.30 use scientific knowledge to explain and understand technological devises;

3.40 know that service can be used to advance technology and that technology can be used to advance science;

3.50 become familiar with some existing and emerging technology.

4.00 Understand the Role of Science and Technology in Societal Issues.

4.10 understand that science and technology influences and are influenced by societal issues;

4.20 understand that many of the effects of science and technology on society are unforeseen;

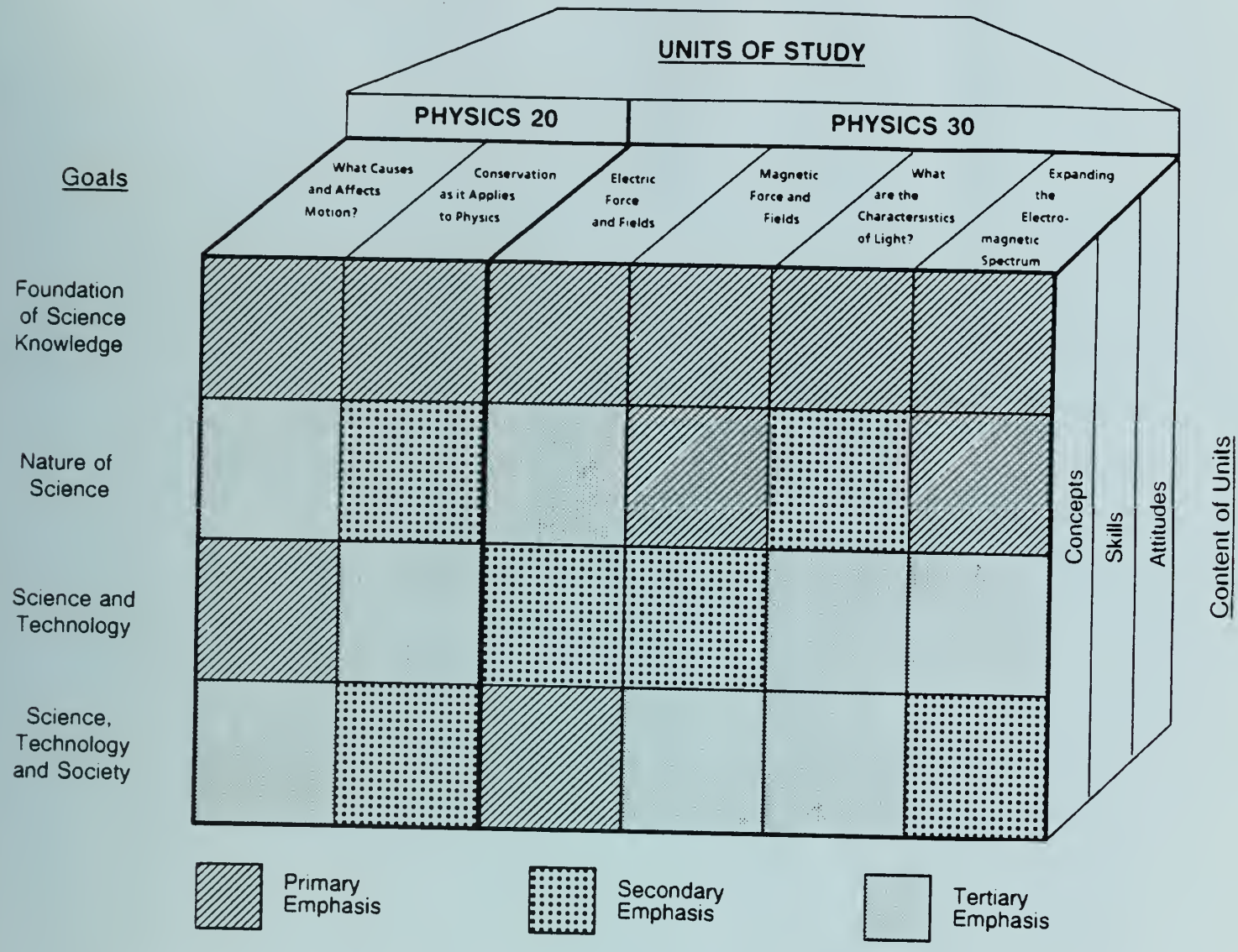
4.30 become aware of the interaction of societal factors such as financial, political, ethical, and moral forces with science and technology;

4.40 appreciate the societal impact on technological processes, techniques and products;

4.50 be aware that trade-offs are made in order to arrive at workable situations involving science and technology in society;

4.60 evaluate the appropriateness of various societal decisions in terms of related scientific and technological thinking.

PHYSICS 20-30 SCOPE AND SEQUENCE



UNIT I: WHAT CAUSES AND AFFECTS MOTION?

OVERVIEW:

This unit provides an initiation into physics as students have the opportunity to develop methods of describing the motion of objects. In addition, causes of motion and factors affecting motion will be examined.

★ The findings of this unit may be applied to orbital motion and some of the technological considerations associated with motion in space.

CONTENT:

CONCEPTS

1. Science uses mathematics to describe nature and observed phenomena.

   a. explain the difference between scalar and vector quantities (e.g., distance and displacement, speed and velocity, and average speed and velocity).
   b. distinguish between uniform and non-uniform linear motion; acceleration and deceleration; and velocity and instantaneous velocity.
   c. identify uniform motion and uniform acceleration in displacement-time, velocity - time, and acceleration-time graphs.
   d. apply the concepts of slope and area under the curve for displacement-time, velocity -time, and acceleration-time graphs.
   e. analyze situations graphically and mathematically in which distance, displacement, speed, velocity, and acceleration are involved.
   ★ f. describe two-dimensional motions using vector quantities (elective projectile motion and circular motion).
   ★ g. define and explain the following terms related to circular motion; speed, instantaneous velocity, centripetal acceleration, frequency and period.
   ★ h. know the relationship between speed and frequency (or period) for circular motions.
   ★ i. identify the directions of the instantaneous velocity and acceleration of an object undergoing circular motion.
   ★ j. analyze the horizontal and vertical components of projectile motion in order to solve problems.
   ★ k. apply principles of circular motion to the working of the ferris wheel, roller coasters, merry-go-rounds etc.
   ★ l. know that the principles of circular motion were used to predict the paths of some planets and predict their existence.
   m. recognize that knowledge of motion is important for improved performances in athletics and sports.
   n. understand that speed limits are important in controlling traffic flow and human behaviour.
   o. know some applications of computers in analyzing traffic flow problems, monitoring motion of vehicles and assisting public transportation.

2. Changes in motion are the result of unbalances forces and inertia.

   a. know Newton's Laws of Motion.
   b. apply Newton's Laws of Motion to explain 1c - 1f.
   c. know how to determine the unbalanced or applied force on an object in on-and-two dimensional examples using vector scale diagrams.

d. apply Newton's Laws of Motion to describe situations involving forces.
e. know that the force due to gravity on an object is proportional to its mass.
f. distinguish between mass and weight.
g. define newton.
h. explain how Newton's Laws of Motion apply to seat belts in cars and airplanes.
i. relate Newton's Laws of Motion to seat belt legislation, speed limit legislation and anti-skid brakes.
j. explain which laws are involved in rocketry, track and field events, lawn sprinklers, rifle recoil, tug-of-war, opening of a heavy door etc.
★ k. apply centripetal acceleration and force equations to satellite motion.
★ l. explain the cause of weightlessness in a free falling elevator and a spacecraft orbiting the earth.
★ m. determine the conditions required by a satellite to follow a stable circular orbit and predict events should conditions not exist.
★ n. know that centrifuges assist in research in medicine and other areas of science that has benefited humanity.
★ o. recognize that weightlessness in space permits the carrying our of experiments that cannot be conducted easily on earth, and as such, new frontiers of research activity are opening up.
p. investigate one of the following: the effects of seat belts and speed legislation on public safety; a scientific experiment requiring zero gravity; safety features such as anti-skid brakes.

★ to be placed in an elective unit.

SKILLS

1. Identify experimental variables: manipulated/independent; responding/dependent; control.
2. Collect data using appropriate precision with interval (recording) timers.
3. Express measured and calculated quantities in appropriate significant digits.
4. Use unit analysis to check answers to solutions.
5. Solve motion problems using algebraic and/or graphical analysis.
6. Analyze data graphically using line-of-best-fit and/or curve straightening techniques.
7. Interpret described or observed events in the form of algebraic relationships.
8. Perform simple 2-Dimensional vector additions.
9. Manipulate laboratory equipment in order to get reliable experimental data.
10. Employ a variety of approaches in assessing and solving problems.
11. Design experiment(s) required to test a hypothesis.
12. Formulate an experimental hypothesis.
13. Organize and interpret experimental data through appropriate means.
14. Express ideas in appropriate scientific terms and language.

ATTITUDES

1. Develop a positive attitude towards mathematical and scientific processes and skills.
2. Appreciate the relationship between mathematics and the sciences.
3. Appreciate that in solving problem scientifically new technologies and solutions develop.
4. Appreciate the relationship between science and technology.

UNIT II: CONSERVATION AS IT APPLIES TO PHYSICS

OVERVIEW

This unit investigates the principles of conservation in nature as they apply to the fundamental concepts of mass, energy and momentum.

The principles learned are reinforced by analyzing common and practical physical interactions.

Societal issues related to conservation principles and technologies will be addressed.

CONTENT:

CONCEPTS

1. Conservation laws provide a simple means to analyze and explain interactions between objects.

    a. define the following: momentum, impulse, joule and energy.
    b. state the law of conservation of momentum.
    c. state the law of conservation of energy.
    d. know that momentum and energy appear to be conserved during interactions between objects.
    e. recognize that the laws of conservation of energy and mass are scalar in nature.
    f. define and distinguish elastic and inelastic collisions.
    g. recognize that the law of conservation of momentum is vector in nature.
    h. apply the conservation laws to analyze one- and two-dimensional interactions between objects.
    i. recognize that Newton's laws of motion lead to the concept of conservation of momentum.
    k. apply conservation of momentum when explaining rocket propulsion, gun recoil, traffic collisions, billiards, tennis and dancing.
    l. apply impulse to the design of car bumpers, padded dashboards, safety nets and trampolines.
    m. investigate one of the following: design of car bumpers, cost savings to consumers and the insurance industry with the advent of shock absorbing car bumpers and padded dashboards.

2. Mechanical energy interactions involve changes in kinetic and/or potential energy.

    a. define the following: work, kinetic energy, gravitational potential energy, mechanical energy.
    b. know that mechanical energy is the sum of potential and kinetic energy.
    c. Know that work is the transfer of mechanical energy.
    d. Know that power is the rate at which energy is transferred.
    e. Analyze situations involving mechanical energy transfer in terms of work and power.
    f. identify new technologies involving solar energy, wind and tidal energies.
    g. identify implications of increased use of energy by society in developing more efficient transfer of energy (e.g., fuel efficient cars, aerodynamic design, and safety in collisions).

SKILLS

1. Use vectors in analyzing momentum relationships for linear and simple non-linear interactions between two bodies.
2. Solve conservation problems using algebraic and/or graphical analysis.
3. Use unit analysis to check answers to solutions.
4. Express scientific ideas and arguments using correct scientific language and terminology.
5. Formulate experimental hypotheses relating to two body interactions.
6. Design, perform and complete analysis for experiments to test an hypothesis.
7. Approximate, estimate and predict results of interactions based on understanding of conservation laws.
8. Recognize the limits of the laws of science, technology and mathematics in making estimations, approximations and predictions.

ATTITUDES

1. Value the conservation laws as a means of analyzing complex physical interactions.
2. Appreciate the need for simplicity in scientific explanations and the role conservation laws play in many of these explanations.
3. Appreciate the usefulness of computational competence and problem solving skills and develop a positive attitude towards them.

UNIT I: ELECTRIC FORCE AND FIELDS

OVERVIEW:

This unit familiarizes the student with the principles and terminology of electricity and circuits.

Using the technology of circuitry, the students learn how to describe the interactions of electric charges mathematically from empirical data.

Investigations of these interactions lead the student into the study of electric fields and charged-particle dynamics.

The students are to apply their finding to personal, everyday applications of pertinent technological devices.

CONTENT

CONCEPTS

1. The electrical model of matter is fundamental to the understanding of electrical interactions.

   a. know that matter consists of discrete positive and negative particles.
   b. apply the law of conservation of charge to electrical interactions.

2. Coulomb's law describes the relationship between force, charges and separation.

   a. deduce mathematically the relationship of force, charge and distance.
   b. realize the inverse square law, deduced for Coulomb's law, consistently re-occurs in other natural phenomena.(example: Newton's universal law of gravity, illumination or sound intensity).
   c. understand how devices such as electrostatic precipitators and filters are used to clean emissions from power plants and furnaces.

3. Electric field theory is a model to explain how charges interact.

   a. describe and diagram electric fields to model natural electrostatic phenomena.
   b. utilize the laws of conservation of energy (potential difference) and charge in analyzing electrical interactions.
   c. explain how sensitive components in a computer are protected from electric fields.
   d. know how electric fields are used in photocopying machines and liquid crystal displays.

4. Kirchoff's and Ohm's laws are fundamental in explaining simple electric circuits.

   Define current, potential difference, resistance, and power; and know their symbols and SI units.

   a. recognize that Kirchoff's laws are based on laws of conservation of energy and charge.
   b. know the standard symbols used to represent electrical circuits.
   c. identify the advantages of -standardizing' symbols used for circuit diagrams. Define coulomb, ampere and volt.

d. identify advantages of CSA standards regarding electrical wiring codes of safety.
e. analyze simple parallel and series circuits using the variables of potential difference, current and resistance.
f. recognize that Ohm's equation is an empirical relationship rather than a theoretical relationship.

5. Electrical energy is widely used in our society.

a. identify several technological applications of electricity .
b. relate technological applications of electricity to standard of living and life saving medical equipment (e.g., dialysis, respirators, heart and lung machines, pacemakers etc.)
c. know that electricity is used for many leisure activities (e.g., music, radio, films, videotapes etc.)
d. examine the factors that influence the wide use of electrical energy in Canada.
e. identify the factors influencing use of electricity in Alberta.
f. relate use of electricity in Alberta to general energy conservation programs and pollution abatement.
g. describe both positive and negative environmental effects resulting from our society's dependence upon electrical energy.
h. explain how the use of electricity in our society freed us to enjoy more leisure time activities.

Skills

1. Draw electric field diagrams for simple combinations of static charge.
2. Draw and mathematically analyze, simple electric circuits.
3. Use unit analysis to check solutions.
4. Apply the complete scientific process in experiments on electrostatics and electric circuits.
5. Identify and utilize a variety of approaches for assessing and solving problems.
6. Develop a model for electrostatics in terms of a two charge system.

Attitudes

1. Develop a positive attitude towards mathematical and scientific processes and skills. Follow safe practices when working with electricity.
2. Appreciate the usefulness of computational competence and problem solving skills.
3. Appreciate that in solving problems scientifically new technologies develop.
4. Appreciate the relationship among science, technology and society.
5. Continue to develop responsible attitudes to environmental and social change due to the use of electrical energy and its production.

UNIT II: MAGNETIC FORCE AND FIELDS

OVERVIEW:

Students are introduced to motors and transformers as technological devices through the interaction of electricity and magnets.

The physics behind these devices is investigated through the observable and measurable properties of magnets and the concept of 'field' from which the students are to construct a theory regarding 'magnetic fields'.

The theory is tested through various applications, modified, and then reapplied to new situation and devices.

CONTENT:

CONCEPTS

1. Field theory can be used to explain magnetic interactions.

    a. explain magnetic interactions in terms of vector fields.
    b. recognize similarities between electric, gravitational and magnetic fields.

2. Magnetic fields and forces are described in relation to electric currents.

    a. identify the discoveries of Oerstad and Faraday as forming the foundation of the theory relating electricity to magnetism.
    b. know that a magnetic field surrounds a moving charge.
    c. predict how magnetic fields affect moving charges.

3. Electromagnetic interactions are commonly used in modern technology.

    a. identify several applications of electromagnetic technology (examples: motor, transformer, generator, CRT, cyclotrons, vidicon camera tube, VCR, audiotapes and FAX).
    b. describe the operation of a technological device or process that use electromagnetic principles and one which depends upon the dynamics of moving charges (example: see 3a).
    c. research and/or design and/or construct a device or process that utilizes electromagnetic principles.
    d. recognize that high voltage AC transmission allows for long distance transmission of electric energy generated at source thus permitting separation of source and place of use.

4. Lenz's law explains electromagnetic interactions in terms of conservation of energy laws.

    a. identify situations in which Lenz's law applies (examples: back emf of a motor, force needed to turn a generator, laminated construction of a transformer core).
    b. describe how Lenz's law applies in the situations previously identified.
    c. discuss Lenz's law in terms of conservation of energy.

SKILLS

1. Draw field diagrams for magnetic fields resulting from magnetic poles or current carrying conductors.
2. Apply the complete scientific process in experiments on magnetic field-current interactions.
3. Analyze motions of charge particles in uniform electric and/or magnetic fields.
4. Use LHR or RHR (hand rules) to predict the relative directions of motion, force and field.

ATTITUDES

1. Appreciate that in solving problems scientifically new technologies develop.
2. Appreciate the relationships among science, technology and society.
3. Value the contributions of science, technology and mathematics to our cultural heritage.
4. Confidence that mastery of basic physics concepts enables one to understand the workings of technological devices.
5. Appreciate parallelism in the studies of electrical, magnetic and gravitational phenomena.

UNIT III: WHAT ARE THE CHARACTERISTICS OF LIGHT?

OVERVIEW:

In this unit the observable properties of light are presented and analyzed.

The development is to centre around model building, process skills and the use of mathematical skills while learning the fundamental ideas associated with geometrical and wave optics.

Technological applications of light will be explored.

CONTENT:

CONCEPTS

1. Geometric optics can be used to describe observed phenomena in light.

    a. describe the following properties of light: linear propagation, speed, refraction, reflection and dispersion.
    b. define and use terminology associated with optics (examples: normal, angle of incidence, focal length, converging lines, diverging lens, real image, virtual image, magnification, object distance, image distance, and visible spectrum).
    c. state laws and formulas which describe observed phenomena (example: Snell's Law, $1/d_o + 1/d_i = 1/f$).
    d. deduce the laws of reflection and refraction from their experiments.
    e. apply and compare formula and ray tracing methods for solving optics problems.
    f. derive theoretical equations by analysis of geometrical diagrams (example: Snell's Law and $1/d_o + 1/d_i = 1/f$).
    g. recognize the technological applications of reflection, refraction and linear propagation (examples: lenses, telescopes, microscopes, spectacles, scanners, laser disc, eye surgery and identification of transparent substances and concentration of solutions).
    h. understand the operation of the human eye and the use of lenses to correct vision problems.
    i. apply geometric optics to optical instruments such as the telescope, microscope projector, camera and photocopier.

2. Models are developed to help man 'understand' and organize information. (What is the "stuff" of light?)

    a. describe how the particle model explains light phenomena.
    b. identify wave characteristics and behavior.
    c. describe how the wave model explains light phenomena.
    d. recognize that models are modified as new phenomena are discovered (evolution and tentativeness of a light related model).
    e. identify situations where models predict new light phenomena (example: Poisson's spot).
    f. describe how models may predict technological applications of light (examples: lasers, holography, fiber optics).

3. Wave optics explain light phenomena that geometric optics cannot.

   Define and use terminology associated with waves (examples: wavelength, frequency, amplitude, vibration, plane-polarized light, diffraction, and constructive and destructive interference).

   a. realize the limitation of geometric optics in explaining light phenomena (examples: diffraction, interference and polarization). Apply the principle of superposition when two waves interact.
   b. analyze interference, diffraction, and polarization in terms of the wave model (i.e., explanations and problem solving). Describe the function of Polariod filters, including sun glasses.
   c. identify the limitations of the wave model (i.e., photoelectric effect, lasers).
   d. describe applications of wave optics to optical technology (examples: short distance measurement, lens coatings, measurement standards).
   e. investigate at least two uses of lasers (examples: laser surgery, holography).
   f. apply the principle of interference to the interferometer).
   g. investigate how polarization has enabled scientists to study the shape and properties of molecules in solutions.

4. Postulated entities (photons, light waves) are used in science in the creation of models.

   a. realize the need to develop a conceptual entity (photon) to explain the radiation of black body, photoelectric effect and emission spectra.
   b. realize the principle of conservation of energy applies to technological devices (examples: solar cells, lasers).

SKILLS

1. Collect data in an experimental setting.
2. Organize data for analysis.
3. Identify experimental variables.
4. Formulate experimental hypotheses.
5. Manipulate laboratory apparatus in order to collect reliable data.
6. Analyze data using graphs or other techniques to discover relationships.
7. Express scientific ideas and arguments using proper terminology.
8. Express and solve problems using various approaches (ray diagrams and formulas).
9. Develop scientific models from observed phenomena.

ATTITUDES

1. Develop a positive attitude towards mathematical and scientific processes and skills.
2. Appreciate the relationship between mathematics and the sciences.

3. Appreciate that in solving problem scientifically new technologies and solutions develop.
4. Be open to new ideas, insights and change.

UNIT IV: EXPLORING THE ELECTROMAGNETIC SPECTRUM

OVERVIEW:

This unit presents the unification of the wave and particle models of light into a single coherent theory.

It presents an extension of visible-light spectrum into the full range of electromagnetic radiation.

Technological applications of electromagnetic radiation are to be studied from the perspective of the science beyond these technological devices and processes.

Using the technologies studied examine some of the societal factors that are involved in their applications.

CONTENT:

CONCEPTS

1. Maxwell's theory of electromagnetism expanded on Oerstad's and Faraday's generalizations.

    a. know that Maxwell went beyond experimental results in developing his theory.
    b. describe Maxwell's theory of electromagnetism.
    c. describe the electromagnetic spectrum.
    d. explain the experimental results which confirmed Maxwell's theory.

2. The quantum theory was used to explain the photoelectric effect.

    a. define and use terminology associated with photons (examples: photon, photoelectric effect, work function, wave-particle duality, quantum, and quanta).
    b. describe the photoelectric effect.
    c. investigate at least two uses of the photoelectric effect and photoactive processes (examples: automatic door opener, light meters, burglar alarms, photodiode, photosynthesis, photochemical reacitons).
    d. analyze the photoelectric effect in terms of quanta and conservation of energy.
    e. know the conditions necessary for photoelectric emission.
    f. analyze the relationship among the number of photoelectrons emitted, their energy, the material of the emitter, the intensity and wavelength of light for the photoelectric effect and the stopping voltage.
    g. know the contributions of the following scientists: Einstein, Planck, and Hertz.
    h. recognize that wave-particle duality is needed to explain e.m.r. phenomena.
    i. recognize that the particle-like behavior of e.m.r. increases as the frequency increases.
    j. describe the Compton effect qualitatively, identify the conditions under which it occurs, and realize its significance in supporting the theory that e.m.r. can exhibit particle-like behavior.

3. The theory of electromagnetic waves has given rise to many technological innovations.

    a. identify some of the technological innovations produced from electromagnetic wave theory (examples: television and telephone information transmitted by microwave relay towers and geosynchronous satellites, navigation by radar, radio telescopes, radio control of satellites, space probes, missiles and drones, infra red waves for remote sensing and thermography, killing bacteria with UV waves, X-rays for diagnosis and

therapy in medicine and metal fatigue testing in industry, gamma rays in the treatment of cancer and microwaves in cooking.
b. analyze the operation of these technological innovations using electromagnetic principles.
c. investigate the theory and application of X-ray diffraction.

4. Electromagnetic radiation has implications for society.

a. identify the known effects of electromagnetic radiation on living systems (examples: ultraviolet-skin cancer link, microwaves, X-rays).
b. recognize that continuing research will be needed to ascertain the effect of specific electromagnetic radiation on living systems (examples: low level e.m.r., radiation leakage from nuclear reactors and trapping of infra red radiation emitted by earth to create the "greenhouse effect").
c. evaluate and relate the societal implications of the use of common personal technological devices utilizing electromagnetic principles (examples: microwave ovens, radar, cordless telephones, cellular phones, am and fm radio remote controls).
d. describe how the concept of the "Global Village" is contributed to by application of telecommunication technology (examples: satellite transmission, FAX).
e. recognize that telecommunication technology allows viewers a wide choice of programming but may pose a threat to Canadian culture and identity.
f. be aware of the contribution of electromagnetic spectrum technology to cosmology.
g. investigate how remote sensing by satellites is used for resource mapping and enforcing arms-control agreements.

SKILLS

1. Compare and contrast the various segments of the e.m.r. spectrum.
2. Predict wave versus particle effects for various segments of the e.m.r. spectrum.
3. Discuss evidence to show that e.m.r. displays a wave and/or particle nature.
4. Discuss how modern technology uses e.m.r. (in communication, medicine, etc.?).

ATTITUDES

1. Appreciate the relationships among physics, technology and society.
2. Appreciate the need for careful decision making in the use of our technology.
3. Value different perspectives of the same phenomena as each making unique contributions to our understanding.
4. Value the contributions of physics and mathematics to our cultural heritage and to the progress of civilization.

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